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Research Article

Analysis of Soil Quality Around Biopore Infiltration Pits in Ciputri Village

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Abstract

Soil quality is the capacity of land to provide functions needed by humans and ecosystems over a long period of time. Soil quality indicators are physical, chemical and biological properties of the soil that describe the condition of the soil. Biopore infiltration holes are a technology used to increase water recharge, utilizing the role of soil fauna and plant root activities. This study aims to determine the quality of soil on residential land as a result of the application of biopore holes. The research was conducted on residential land in Ciherang Hamlet, Ciputri Village, Cianjur Regency from April to October 2023, using experimental methods and laboratory analysis. Data analysis using the LandPKS application and Shanon Wiener formula and Lowery scoring method. The results showed that the dominant soil color was dark. pH and C-Organic soils are interconnected. The soil pH obtained ranges from 5.6 - 7.6 with an average of 6.87 which indicates an acidic pH and safe for macrofaunal life. C-Organic soil has increased with moderate category after average, C-Organic has increased because pH has increased. Macroorganisms have increased the number of families, from 6 families to 11 families with a medium diversity index and a high evenness index. Biopore holes filled with organic waste from food waste affect soil quality.

Keywords: Biopore Absorption Holes; Residential Land; Soil Quality

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INTRODUCTION

The phenomenon of waste in Indonesia according to data from the National Waste Information System (SIPSN) Indonesia stockpiled waste in 2021 as much as 23,671,232.60 tons and 40.92% from household areas [1]. Food waste is the most common type of waste generated at 29.2%. Household waste is waste generated from daily activities in the household and does not include feces and specific waste. One of the problems of poor waste management can lead to flooding, flooding can be caused by the decreasing availability of land surface for water absorption[2]

Fertile soil has good quality. Soil quality is the capacity of a soil in a field to provide functions required by humans or natural ecosystems over a long period of time. Soil quality is assessed based on soil physical, chemical and biological properties or indicators that describe important processes in the soil. The negative impact of the inability of soil to fulfill its function is the disruption of soil quality, resulting in the increase of critical land, decreased soil productivity and environmental pollution [3]. One of the causes of the decline in soil quality is due to poor waste management [4] such as burning, dumping into drainage, or scattering.

Soil quality in Cianjur District is categorized as lightly damaged and soil quality in Ciputri Village is categorized as lightly damaged [5], Ciputri Village does not yet have a temporary waste disposal site (TPS), in Pacet Sub-district itself TPS are located in two villages, namely Ciherang Village and Sukanagalih Village. According to the existing phenomenon, researchers found several piles of garbage that did not fit in place because of the lack of public awareness of environmental cleanliness and the usefulness of infrastructure. The existence of infrastructure facilities and infrastructure in settlements such as drainage is still misused by the community to dispose of household waste. In addition, the lack of land owned by the community requires household waste infiltration so that people do not throw or drain household waste into drainage.

Land that is not so wide, waste management and reducing damage to the soil requires efforts to overcome and optimize the land by managing waste, by making biopori holes is one way that can be used to overcome the problem of waste and soil quality [6]. Biopore infiltration holes are spaces or pores in the soil formed by living things, such as soil microorganisms and plant roots. The shape of a biopore resembles a small, branching burrow that is very effective at absorbing water into the soil. Various sizes and types of soil organisms live between the pores and through the pores the organisms obtain water and oxygen while food is obtained from organic matter in the form of weathering of plant remains and other living things [7]. The benefits of biopores are that composting can be managed directly at the source so that it does not need to be transported to landfills and costs are cheaper and do not cause environmental pollution [8]. This research was conducted to determine soil quality with soil physics parameters (soil color), soil chemistry (pH and C-Organic), and soil biology (macroorganisms) around biopore infiltration holes in Ciputri Village. The results of this study certainly contribute to good waste management that does not damage the environment to the Ciputri Village community. This research can be used as a reference material for biology practicum on environmental pollution material.

METHODS

Research Location

This research was conducted in Ciherang Hamlet, Ciputri Village, Pacet District, Cianjur Regency and at the Bogor Soil Research Center Testing Laboratory. The research population was Ciherang Hamlet, the research sample was 20 biopore infiltration holes and for soil quality measurements 5 points were taken from the biopore infiltration holes, this was done with consideration of the area of the yard in the settlement.

Field Observation, Making Biopore Infiltration Holes, Soil Sampling

The research was conducted from April to October 2023, using quantitative research with an experimental approach. Field observations were conducted to determine the initial state of field conditions to determine the location of biopore infiltration holes and to determine the situation after making biopore infiltration holes.

The technique for making biopore infiltration holes is :

1. Determine the location of the biopori infiltration hole (LRB) as many as 5 points and then make a hole using a biopori drill with a diameter of 10 cm.
2. Drill to a depth of 50 cm
3. The edge of the LRB is hardened with cement to prevent erosion at the edge of the LRB.
4. Closing the LRB with a lid that is easy to open to insert organic waste [9]
5. The distance between biopore holes is 50cm [10] because it is adapted to the limited land.
6. Every 50m2 of land area a hole is made [10]

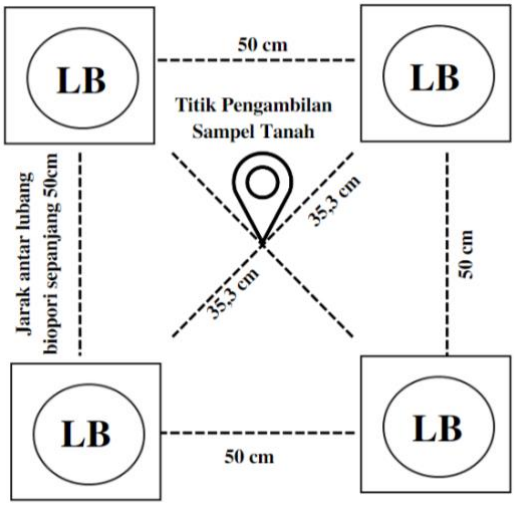

***Figure 1**. Distance between Biopore Infiltration Holes*

Soil sampling was carried out twice, namely before and after making biopore infiltration holes, by taking disturbed soil samples [11]. Soil sampling in zigzags to get a general picture in a relatively homogeneous plot of land [12]

Data Analysis

Soil color was measured using the *LandPKS* application [13] dan dideskripsikan. Makroorganisme tanah dapat dihitung menggunakan indeks keanekaragaman Shannon Wiener (H') and described. Soil macroorganisms can be calculated using the Shannon Wiener diversity index (H') [14] and species evenness index (E) [15]. Soil pH and soil C-Organic were calculated using the Lowery scoring method [16].

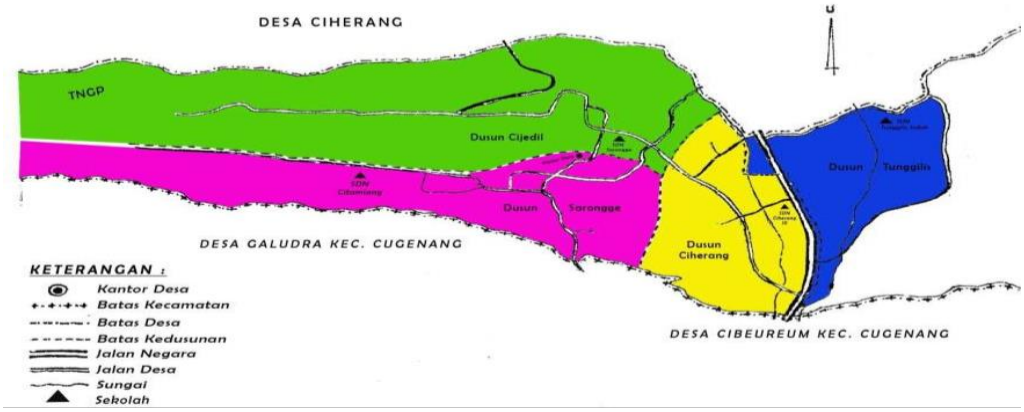

Figure 2. Map of Ciherang Hamlet

Figure 3. Soil Sampling: *soil sampling point: biopore hole; collection path*

RESULT AND DISCUSSION

The results of research on soil physical properties show that the color of the soil ateach location point varies consisting of 3 colors, namely *dark reddish brown, reddish brown, dusky red*. Before the application of biopore holes, the soil color consists of *dusky red, reddish brown and dark reddish borwn,*

while after the application of biopore holes, the soil color tends to be *darker* than before the application of biopore holes, namely *dark reddish brown*. The most dominant soil color from both biopore applications is *dark reddish brown*. The color of the soil as a whole tends to be dark.

Table 1. Soil Color

Location	Before applying biopore holes	After Application of Biopore Holes
Point 1	10 R 3/2 dr	2.5YR 2/6 drb
Point 2	5 YR 3/7 drb	2.5 YR 2/4 drb
Point 3	5 YR 3/4 drb	2.5 YR 2/5 drb
Point 4	2.5 YR 2/5 drb	2.5 YR 2/4 drb
Point 5	5 YR 4/5 rb	5 YR 3/6 drb

The results of research on soil chemical properties can be obtained pH values between 5.2 - 7.6 with an average of 6.68, this indicates that the pH is neutral. The results of soil pH measurements show the highest results in pH H2O at points 4 and 5 after applying biopore holes with a value of 7.6, while the lowest results in pH KCl at point 1 before applying biopore holes with a value of 5.2. C-organic before the application of biopore holes C-organic soil average is low with a value of 1.9. C-organic results have increased after the application of biopores, the average is moderate with a value of 2.2

The results of research on soil biological properties showed that macroorganisms before the application of biopore holes found as many as 6 families of soil macrofauna with a total of 28 individuals consisting of the family Formicidae 1, Formicidae 2, Achatinidae 1, Formicidae 3, Coccinellidae, Tylenhidae, Gryllidae, Megascolecidae. After applying biopore holes, 11 families of soil macrofauna were found with a total of 59 individuals consisting of the families Formicidae 1, Formicidae 2, Termitidae, Achatinidae 1, Achatinidae 2, Laelapidae, Trombiculidae, Passalidae, Sciaridae, Salticidae, Araneidae, Scarabaeidae, Megascolecidae.

Table 2. Soil pH and C-Organic

Location	pH				C-Organic	
	pH H2O		pH KCl			
	Before	After	Before	After	Before	After
Point 1	5,6	6,1	5,2	5,3	2,25	2,54
Point 2	6,6	6,4	6,4	6,1	2,72	3,69
Point 3	6,7	7,1	6,4	6,3	1,49	1,56
Point 4	7,6	7,6	7,5	7,3	1	1,07
Point 5	7,4	7,6	7,1	7,2	2,3	2,41

Table 3. Macrofauna Before the Application of Biopore Infiltration Holes

Family	**Location**					**Number of Individuals**
	Point 1	**Point 2**	**Point 3**	**Point 4**	**Point 5**	

Formicidae 1	-	1	1	-	-	2
Formicidae 2	4	5	2	-	1	12
Achatinidae 1	5	-	1	2	-	8
Formicidae 3	1	-	-	1	-	2
Coccinellidae	-	-	-	-	1	1
Tylenhidae	-	-	-	-	1	1
Gryllidae	-	1	-	-	-	1
Megascolecidae	-	1	-	-	-	1
Total	10	8	4	3	3	28

This table shows the distribution of macrofauna families at different points before the biopore infiltration holes were applied. The most frequently found family was Formicidae 2, with 12 individuals, followed by Achatinidae 1 with 8 individuals. Other families such as Gryllidae, Coccinellidae, Tylenchidae, and Formicidae 1 and 3 were also found but in smaller numbers. The overall total of individuals across all points was 28, indicating moderate macrofauna activity in the area.

Table 4. Macrofauna after applying biopore infiltration holes

Family	**Location**					**Number of Individuals**
	Point 1	**Point 2**	**Point 3**	**Point 4**	**Point 5**	
Formicidae 1	5	-	-	-	2	7
Formicidae 2	3	4	3	4	4	18
Termitidae	2	-	-	-	1	3
Achatinidae 1	10	2	-	2	-	14
Laelapidae	-	-	-	1	-	1
Trombiculidae	2	-	-	-	-	2
Passalidae	2	-	-	-	-	2
Sciaridae	3	-	-	-	-	3
Salticidae	-	-	1	-	-	1
Araneidae	-	-	-	1	-	1
Achatinidae 2	-	-	1	-	1	2
Scarabaeidae	-	2	-	1	-	3
Megascolecidae	-	1	-	1	-	2
Total	27	9	5	10	8	59

After the application of biopore infiltration holes, a noticeable increase in both the number of macrofauna families and individuals was observed. The total number of families increased to 11, with Formicidae 2 remaining dominant with 18 individuals. Additionally, new families such as Termitidae, Laelapidae, and Scarabaeidae appeared, contributing to the increased total of 59 individuals. This demonstrates that the biopore holes have significantly enhanced the biodiversity and population density of macrofauna in the area.

The color of the soil at the research site as a whole tends to be dark. The higher the organic content of the soil, the darker the soil color and the more it tends to absorb solar energy [17].

The ideal soil pH for the life of soil organisms is 6-7 because if the pH is too alkaline and too acidic it will cause living things to die or imperfect life [18]. At the research location, the pH value was obtained between 5.2 - 7.6 with an average of 6.68, this shows that the pH is neutral and the pH of this soil is safe for the life of macrofauna so that at the location soil macrofauna are still found. The results also showed that the pH of H2O was higher than the pH of KCl. This is because the acidity measured using H2O is active acidity while the pH of KCl measures active acidity and potential acidity. KCl is able to measure the H + activity outside the soil because the K + ions from KCl can be exchanged for H + ions, while this does not apply to H2O [19]. The soil quality index at pH before applying the biopore hole is less healthy, the pH has increased after applying the biopore hole to be healthy.

Soil C-organic content indicates the level of organic matter contained in the soil [20]. Soil C-organic content can be affected by soil pH. Extreme pH levels (very acidic or very alkaline) can limit the activity of soil organisms so that it has an impact on the rate of decomposition of organic matter. before the application of biopore holes, the average soil C-organic content was low with a value of 1.9. C-organic results increased after the application of biopore holes, the average was moderate with a value of 2.2. C-organic increased because the soil pH value increased after the biopore holes were applied. However, at the location of point 2 the soil pH decreased while C-organic increased. The decrease in pH from 6.6 to 6.4 may indicate a slight increase in acidity. This change may be due to factors such as the acidity of rainfall or the release of acidic compounds due to the decomposition process. At the same time, the increase in C-organic from 2.7 to 3.69 may be due to an increase in the accumulation of organic matter. Factors such as the inclusion of organic waste or a decrease in the rate of decomposition due to environmental conditions can contribute to an increase in Corganic levels despite changes in pH. The soil quality index in C-Organic before the application of biopore holes received a low score with unhealthy criteria, C-Organic increased after the application of biopore holes to healthy criteria with a medium score.

The diversity index at the study site falls into the low-medium category. Low diversity is due to environmental pressures that always change over time and the influence of human activities. Meanwhile, moderate diversity indicates that productivity is sufficient and the ecosystem is quite balanced due to moderate ecological pressure. Moderate diversity is due to the number of families that live in the location not many species and individuals who inhabit the location are unique [21]. Based on the evenness index value of the species at each point location before and after applying the biopore hole successively shows a high evenness index value, this happens because if each species has the same number of individuals, then the community has a high evenness of species [22]. The conditions that occur at each point location have an evenness index of more than 0.6, where the community is stable. This can occur because the evenness of the number of species present at the point location does not dominate.

CONCLUSION

The soil quality in Ciputri Village has been significantly influenced by the implementation of biopore infiltration holes. Prior to the application of these holes, the soil was categorized as mildly damaged. However, post-implementation, soil conditions improved, moving towards a healthier category. This improvement was marked by several key factors: an increase in soil pH, better C-organic content, and greater biodiversity in soil macrofauna. The pH levels remained within a neutral range, creating an optimal environment for soil organisms, while the rise in C-organic content indicated improved nutrient retention and soil fertility. Moreover, the diversity and evenness of soil macrofauna increased, reflecting a more balanced ecosystem post-application. For future research, more detailed investigations using additional tools such as the Munsell Color Chart could provide greater accuracy in determining soil characteristics. It is also recommended to further explore the biological properties of the soil at the species level, which could offer deeper insights into the ecological benefits of biopore systems. The application of biopore infiltration pits demonstrates a practical and sustainable method to improve soil health, particularly in residential areas where space and resources for soil management are limited. This approach contributes not only to enhancing soil quality but also to broader environmental management practices, such as water absorption and organic waste reduction, making it a valuable solution for sustainable land use in similar settings .

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CONFLICT OF INTEREST

"The authors declare no conflict of interest."

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